CLAIMS

1. A method for measuring bone age comprising:

transmitting an acoustic energy into the body of a subject;

receiving an acoustic signal from one or more structures including an ossification-actuated skeletal structure or a cranial structure that changes with age, responsive to said transmitted acoustic energy;

analyzing the acoustic signal to determine at least one effect of said structure on said signal; and

estimating the age of the structure from said determined effect.

2. A method according to claim 1 wherein said ossification-actuated skeletal structure comprises one or more areas undergoing ossification.

3. A method according to claim 1 wherein said ossification-actuated skeletal structure comprises one or more bones.

4. A method according to claim 1 wherein said ossification-actuated skeletal structure comprises one or more regions of cartilage.

5. A method according to claim 1 wherein said ossification-actuated skeletal structure comprises one or more regions of non-cartilage soft tissue.

6. A method according to claim 5 wherein said ossification-actuated skeletal structure comprises one or more regions of fibrocartilage.

7. A method according to claim 1 wherein said ossification-actuated skeletal structure comprises a region with one or more primary ossification centers.

8. The method according to claim 7 wherein said ossification-actuated skeletal structure comprises one or more of: the bones of the wrist, the bones of the palm, the bones of the tarsus, the mandible.

9. A method according to claim 1 wherein said ossification-actuated skeletal structure comprises a region with one or more secondary ossification centers.

10. The method of claim 9 wherein said ossification-actuated skeletal structure contains an epiphysis.

11. The method of claim 9 wherein said ossification-actuated skeletal structure comprises a region of one or more of: an ulna, a radius, a femur, a bone of a ray of an extremity.

12. A method according to claim 1 wherein said receiving comprises utilizing two or more different acoustic signals to provide a measure of bone age.

13. A method according to claim 12 wherein said two or more acoustic signals are associated with the same bone.

14. A method according to claim 12 wherein said two or more acoustic signals are associated with paths in different bones.

15. A method according to claim 12 wherein said two or more acoustic signals are received from the same direction.

16. A method according to claim 12 wherein said two or more acoustic signals are received from the different directions.

17. A method according to claim 12 wherein said signal passes through said one or more structures including an ossification-actuated skeletal structure.

18. A method according to claim 1 wherein said signal echoes from said one or more structures including an ossification-actuated skeletal structure.

19. A method according to claim 1 wherein said analysis of said signal is responsive to speed of sound from said one or more structures including an ossification-actuated skeletal structure.

20. A method according to claim 1 wherein said analysis of said signal is responsive to broadband ultrasound attenuation from said one or more structures including an ossification-actuated skeletal structure.

21. A method according to claim 1 wherein said analysis of said signal is responsive to dispersion of ultrasound from said one or more structures including an ossification-actuated skeletal structure.

22. A method according to claim 1 wherein said analysis of said signal is performed, at least in part, in the frequency domain.

23. A method according to claim 1 wherein said analysis of said signal is performed, at least in part, in the time domain.

24. A method according to claim 1 wherein said analysis of said signal is responsive to attenuation of an ultrasound signal in said one or more structures including an ossification-actuated skeletal structure.

25. A method according to claim 1 wherein said analysis is used to adult stature.

26. A method according to claim 1 wherein, to provide an estimate of bone age, said analysis is compared to a database having correlation with one or more of: conventional radiographs, CT images, MRI images and Nuclear Medicine scans.

27. A method according to claim 1 wherein said receiving is from a scanning acoustic signal transmitter.

28. A method according to claim 1 wherein said receiving is from a multi-beam acoustic signal transmitter.

29. A method according to claim 1 wherein said receiving provides two or more acoustic signal measures along an axis of said one or more structures including an ossification-actuated skeletal structure.

30. A method according to claim 1 wherein said receiving provides two or more acoustic signal measures radially around said one or more structures including an ossification-actuated skeletal structure.

31. A method according to claim 1 wherein said analysis is correlated with a known bone age measurement system.

32. A method according to claim 1 wherein said analysis is responsive to a formula providing a correlation with a known bone age measurement system.

33. A method according to claim 32 wherein said formula is responsive to at least one of speed of sound, broadband ultrasound attenuation, scattering and dispersion of acoustic signal through or from an ossification activated skeletal structure.

34. A method according to claim 32 wherein an estimate of bone age is responsive to time of flight of an acoustic signal between two transducers, with said ossification activated skeletal structure being situated intermediate to said transducers.

35. A method according to claim 26 wherein separate formulas are used to correlate known bone age data with acoustic signals from males and females.

36. A method according to claim 1 wherein said acoustic information is constructed into a database of bone age measurements.

37. A method according to claim 36 wherein said database is arranged according to one or more of: sex, ethnic group, geographic location, nutrition and general inheritance.

38. A method according to claim 36 wherein said database includes two or more

measurements of one or more of said one or more structures including an ossification-actuated skeletal structure.

39. A method according to claim 36 wherein said database includes one or more measurements of two or more growth stages from said one or more structures including an ossification-actuated skeletal structure

40. A method according to claim 36 wherein said database includes one or more measurements of said one or more structures including an ossification-actuated skeletal structure in two or more populations.

41. A method according to claim 36 wherein said received signals are compared to similar signals in a database to predict one or more of predict one or more of adult bone length, density, thickness and resilience and adult stature.

42. A method according to claim 36 wherein said received signals are compared to similar signals in a database to indicate a bone-growth related disorder.

43. A method according to claim 36 wherein said received signals are compared to similar signals in a database to track the progress of a bone-growth related disorder.

44. A method according to claim 36 wherein said received signals are compared to similar signals in a database to track hormone therapy in a growth stature disorder.

45. A method according to claim 36 wherein said received signals are compared to similar signals in a database to indicate one or more growth-plate related disease states, including osteogenic sarcoma, slipped growth plate, premature arrest of growth plate growth and inflammation of growth plate.

46. A method according to claim 36 wherein two or more acoustic measurements are made on a single subject and entered into said database.

47. A method according to claim 36 wherein said two or more acoustic measurements

are compared to track one or more growth-related disorders, including precocious puberty, delayed puberty, rickets, kwashiorkor, hypoparathyroidism, pituitary dwarfism and diabetes.

48. A method according to claim 36 wherein said two or more acoustic measurements are compared to track treatment of one or more growth-related disorders, including precocious puberty, delayed puberty, rickets, kwashiorkor, hypoparathyroidism, pituitary dwarfism and diabetes.

49. An apparatus for estimating bone age comprising:

an acoustic transmitter and an acoustic receiver positioned on either side of one or more structures including an ossification-actuated skeletal structure;

an electronic moveable gantry that adjusts the position of said acoustic transmitter and said acoustic receiver in relation to said ossification-actuated structure;

a computer system that performs one or more functions of:

positioning of said moveable gantry;

controlling acoustic signals transmitted by said acoustic transmitter;

receiving acoustic signals from said receiver responsive to said transmitted signals; and

estimating said bone age responsive to said received signals.

50. The apparatus of claim 49 wherein said apparatus transmits and receives one or more acoustic signals linearly along an axis through said ossification-actuated structure.

51. The apparatus of claim 49 wherein said apparatus transmits and receives one or more acoustic signals radially around an axis through said ossification-actuated structure.

52. The apparatus of claim 49 wherein said computer system controls said acoustic signal transmitter to provide an acoustic signal appropriate for said ossification-actuated structure.

53. The apparatus of claim 49 wherein said computer system estimates said bone age responsive to one of more of: broadband ultrasound attenuation, acoustic backscatter,

dispersion of acoustic signal and speed of sound in said ossification-actuated structure.

54. The apparatus of claim 49 wherein said computer system uses an imager to control the position of said acoustic signal receiver and said acoustic signal transmitter.

55. The apparatus of claim 49 said computer system contains a visual display to provide information on said bone age.

56. The apparatus of claim 55 wherein said visual display comprises a graph.

57. The apparatus of claim 49 wherein said computer system is comprised in a computer network.

58. The apparatus of claim 49 wherein said computer system comprises a neural network.

59. The apparatus of any of claim 49 wherein said computer system compares said received acoustic signal to a database containing information of one or more acoustic signals from one or more structures including an ossification-actuated skeletal structure to provide an estimate of bone age.

60. The apparatus of claim 49 wherein said computer system compares said received acoustic signal to a database containing information of one or more acoustic signals from one or more structures, including an ossification-actuated skeletal structure to predict stature.

61. The apparatus of claim 49 wherein said computer system compares said received acoustic signal to a database containing information of one or more acoustic signals from one or more structures including an ossification-actuated skeletal structure to indicate, track or follow treatment of one or more of: a bone-growth related disorder, a growth plate disorder, and a growth related disorder.